Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS) – Summer-Fall 2001

CLAMS is a aircraft field campaign that is planned for summer 2001 at the CERES Ocean Validation Experiment (COVE) site – a rigid sea platform 20 km east of Virginia Beach. CLAMS is a clear-sky, shortwave (SW) closure campaign sponsored by CERES, MISR, MODIS-Atmospheres, and GACP. It seeks more accurate

a. broadband fluxes at sea surface and within atmosphere;

b. space-time variability of spectral BRDF of the sea surface;

c. retrievals of aerosols and radiative impacts with satellites.

CLAMS flights seek clear conditions (cloud-free but not aerosol-free). CERES, MISR (Terra), MODIS-Atmospheres, and GACP sponsor CLAMS. Besides the continuous, long-term COVE measuerments, CLAMS will have flights by the NASA ER-2 (Air MISR, MAS, CPL, and possibly other instruments) and the Langley low-level OV-10 (broadband and spectral fluxes, spectral BRDF) aircraft coincident with Terra (~1030 LT). Participtation by the University of Washington mid-level CV-580 (in situ aerosols and chemistry) is probable. The French are considering deployment of the M-20 with an airborne POLDER and LEANDRE (lidar).

CLAMS is needed to fill gaps in SARB validation using COVE. There are two main limitations to the observations of broadband upwelling radiation at COVE. First, the platform obstructs some of the view of the ocean surface. Second, there are uncertainties in how well the ocean directly beneath the platform represents the sea in general. On the larger 20 km scale of a broadband CERES footprint, there are certainly systematic variations in spectral albedo at COVE, which is 20 km off Virginia Beach. MODIS pixels will be used to scale the COVE sea optics to the larger CERES footprint. Does the sea bottom directly under the platform permit COVE measurements to adequately represent the sea within 1 km (the scale of an imager pixel like MODIS)?

The two issues can be resolved by a survey of broadband flux (up and down for SW and LW), downwelling spectral irradiance, and upwelling spectral irradiance and directional radiance with the CERES Fixed wing Airborne Radiometer (C-FAR) on the low-level OV-

10 aircraft. In the months leading up to CLAMS, COVE will have measure the broadband upwelling fluxes (BSRN) and selected SW spectral radiances (SP1-A spectralphotometer) to establish the variations of albedo and BRDF for a wide range of conditions. CLAMS will provide the needed offsets (due to platform obstruction) of those relationships. And by exhaustively covering a few MODIS pixels, CLAMS will permit us to securely “scale-up” MODIS-based sea optics to the larger CERES footprint. MISR Validation has similar concerns about scene variability within its instrument’s FOVs (i.e., Kahn et al., 2000) and plans to use AirMISR on the ER-2, as well as C-FAR on the OV-10.

The variation the spectral SW radiance between imager pixels (MODIS, MISR, or AVHRR) nearby COVE under clear conditions is influenced by the spatial variability of both the sea and the aerosols above it; CLAMS will target both. A particular imager pixel centered on 1 km**2 may be adequeately surveyed near the sea surface by the OV-10, but because the imager views at an angle, aerosols at horizontal distances much greater than 1 km will affect the radiance to the satellite. An accurate “atmospheric correction” to a SeaWifs retrieval, for example, depends on aerosols spread over a larger area than just a single pixel projected to the sea surface. A separation of the spatial variation of aerosol loading from that due to ocean optics is needed to validate accurate retrievals of both quantities. This is especially the case if one seeks to retrieve the low “backround” loading of aerosols that force global climate. The CPL on the ER-2 will be the principal tool in CLAMS for determining the spatial variation of aerosols. Thin vertical “pencil” slices by CPL will be interpreted by MAS and AirMISR images from the ER-2. They will also serve as a testbed for developing algorithms of PICASSO-CENA.

In situ aerosol and chemistry measurements by the CV-580 would provide CLAMS with an even higher level of closure for aerosol optical properties. When combined with the CPL on ER-2 and the COVE surface-based instruments, there would be thorough description of the aerosol; sufficient for rigorous testing of the physical assumptions on aerosols behind the retrievals of MODIS, MISR, GACP and CERES (including the broadband ADM). The vertical profiles of SW retrieved by SARB are strongly influenced by the profiles of aerosol absorption, which can be measured by the CV-580. Aerosol absorption is the principle source of decoupling between aerosol forcing at TOA and at the surface. INDOEX found that surface and TOA forcing differed by roughly a factor of three;

as hypothetical aerosol forcing may be vanishing at TOA but even exceed the forcing of greenhouse gases to the atmosphere itself, this has enormous implications for the global hydcrological cycle. CLAMS should be an excellent database for studies of aerosol assimilation (i.e., Collins and Rasch).

A second CLAMS campaign in fall 2001 may be needed to meet special needs of CERES and MISR, and to extend the application of COVE data to AIRS (Aqua). MISR requires especially stringent cloud free conditions (which may not coincide with the MISR week-long viewing cycle) and prefers low aerosol loadings for validation. The mean aerosol optical depth at COVE in July is about 0.3, which is suitable for MODIS validation. But the conditions required by MISR for coincidence of ER-2 (with AirMISR) and Terra may not be obtained in a single month (i.e., July 2001). A second component of CLAMS in fall 2001 would permit CERES to validate the retrieval of the vertical profile of LW SARB by collaborating with AIRS in checking the vertical profile of water vapor (especially UTH) with an AERI spectrometer at the COVE platform, NAST-I and NAST-MTS on Proteus, and possibly an airborne LASE. The LASE DIAL is probably the most accurate instrument for the measurement of UTH, which is the critical variable in the computation of the LW SARB profile. NAST-I radiances on Proteus, which can operate efficiently at a wide range of altitude, would allow a spectral validation of the broadband LW SARB vertical profiles. In a second CLAMS, CERES OV-10 flights would measure the spatial variations SW sea optics for MISR and spatial variations of ocean skin temperature for AIRS. Such observations of ocean skin temperature and the humidity profiles would provide an ideal input for a theoretical similation of CERES LW TOA radiances and fluxes under clear conditions. Comparably accurate input data would be much more difficult to obtain over land, where surface LW emission varies greatly in space due to canopy orientation, soil moiture and type, and viewing angle relative to the sun (Minnis et al, 2000 and Lin et al. 2000).

Table of CLAMS Aircraft Instruments

Plane/ level	Instrument	Main users	Instrument application
OV-10 low	C-FAR	CERES+MISR +GACP+MODIS	SW+LW broadband fluxes SW spectral flux + BRDF
		CERES+MODIS +AIRS	IR skin temperature
		CERES+AIRS	Humidity profiles
ER-2 high	AirMISR	MISR+CERES	BRDF
	MAS	MODIS+CERES	High resolution imaging
	CPL	MODIS+CERES +MISR+GACP	Aerosol profile
	LAS?	MODIS	BRDF
	LASE?	CERES+AIRS	Humidity profile
CV-580 low-mid	PCASP+FSSP	MODIS+MISR +CERES+GACP	Aerosol optical property profiles
	CAR	MODIS	BRDF
M-20	POLDER	MODIS+MISR +CERES?	BRDF
	LEANDRE	MODIS+MISR +CERES+GACP	Aerosol profile
Proteus all	NAST-I NAST-MTS	AIRS+CERES AIRS+CERES	Profiles of humidity and Spectral LW